U. S. FOREST SERVICE

RESEARCH NOTE LS-17

KE STATES FOREST EXPERIMENT STATION • U. S. DEPARTMENT OF AGRICULTURE

Influence of Regular Spacing on Growth of a Red Pine Plantation

The uniform spacing in plantations is known to influence their early growth and development. Only a few of the older plantations, however, have developed without hardwood overstories or have a continuity of records that show their growth characteristics and yield potentials. The record of an unmanaged 51-year-old red pine plantation in Crawford County, Mich., indicates that regular spacing results in growth characteristics markedly different from those of natural stands (fig. 1).

The study plantation was established by the Michigan Department of Conservation in the fall of 1912, using a 2-0 stock of local origin. The initial spacing, averaging 4½x5 feet, was closer to the generally dense spacing of natural stands than that of later plantings. The planting site was a level field of Grayling sand soil that had been farmed and abandoned a few years earlier. The site quality is medium for red pine, with the average dominant and codominant tree about 51 feet in height at 51 years of age. Survival, averaging 84 percent, was higher than in many of the early plantings, since there was no invasion by hardwoods.

Periodic measurements on a half-acre plot were begun in 1934 when the plantation was 24 years of age from seed. Remeasurements were made in 1939, 1949, 1956, and 1961. To illustrate the differences in growth characteristics, the plantation data at each remeasurement age are compared with those of natural stands[1] on similar sites (table 1).

[1] *Eyre, F. H., and Zehngraff, P. Red pine management in Minnesota. U. S. Dept. Agr. Cir. 778, 70 pp., illus. 1948.*

TABLE 1. — *Stand characteristics at different ages for an unmanaged red pine plantation and yield table values for natural stands, site index 50*

Total age (years)	*Trees per acre*[1]		*Basal area per acre*[1]		*Av. d.b.h.*[1]		*Cubic vol. per acre*[2]		*Cordwood vol. per acre*[2]	
	Plantation	Natural stand	Plantation	Natural stand	Plantation	Natural stand	Plantation	Natural stand	Plantation	Natural stand
	Number	*Number*	*Sq. ft.*	*Sq. ft.*	*Inches*	*Inches*	*Cu. ft.*	*Cu. ft.*	*Cords*	*Cords*
24	1,568	2,100	88	93	3.2	3.1	17	275	0.2	3.2
29	1,568	1,262	134	105	4.0	4.0	316	594	4.0	7.9
39	1,518	732	199	123	4.9	5.7	1,605	1,327	21.0	18.7
46	1,468	569	224	134	5.3	6.6	2,630	1,875	33.7	26.6
51	1,404	510	236	140	5.5	7.2	3,371	2,235	41.9	31.5

[1] *Trees 0.6 inch and larger.*
[2] *Trees 4.6 inches and larger to a 4.0-inch top diameter inside bark.*

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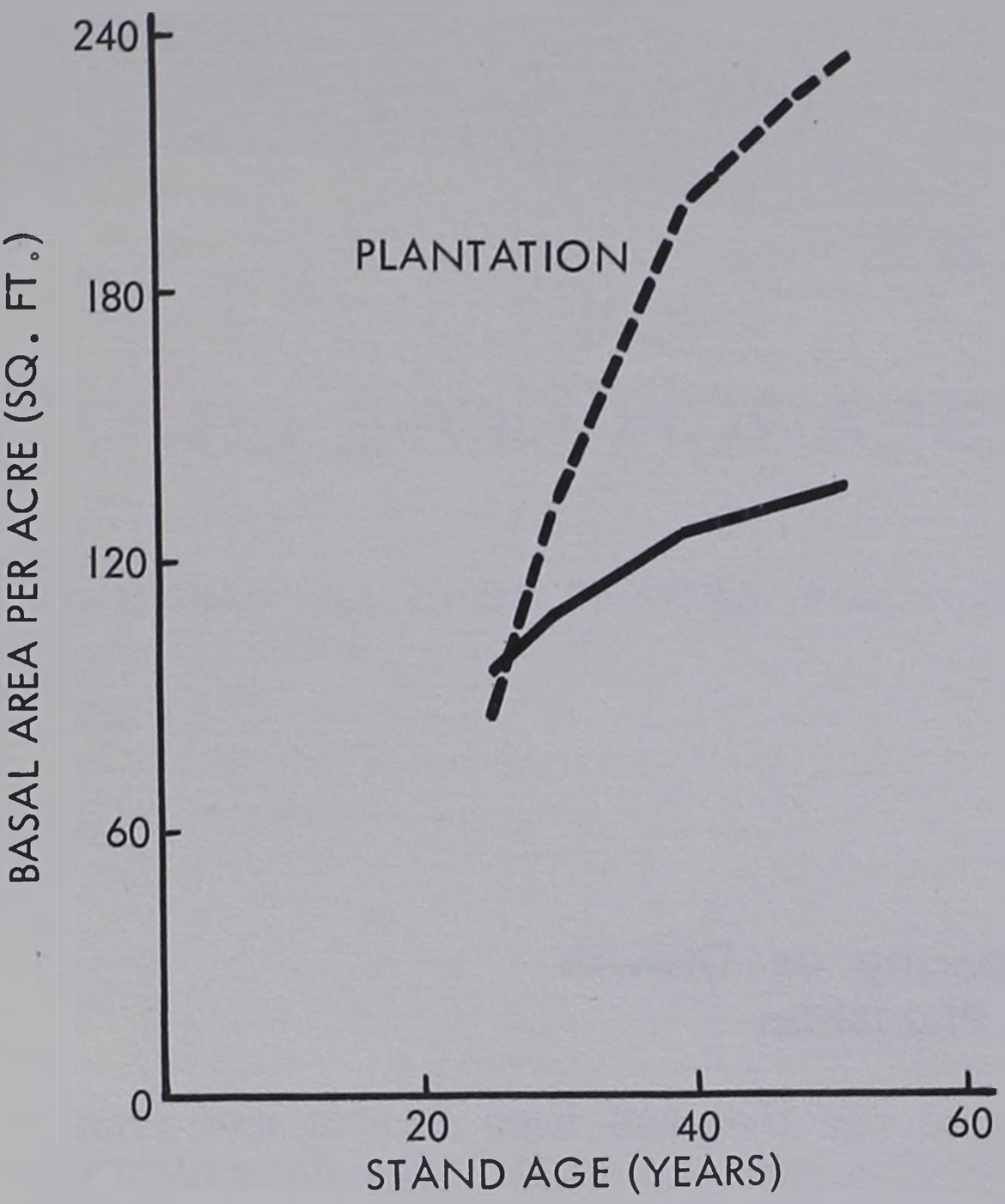

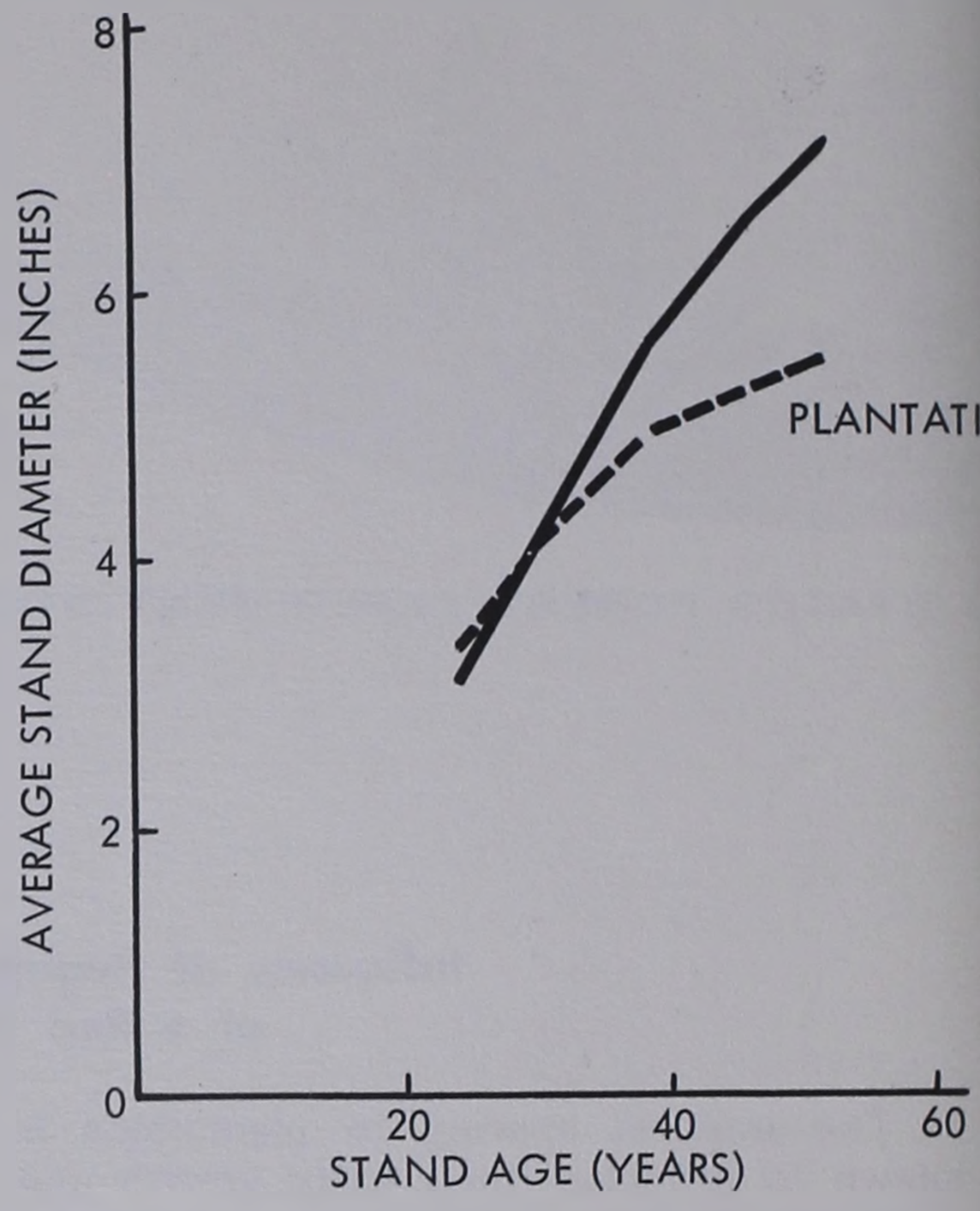

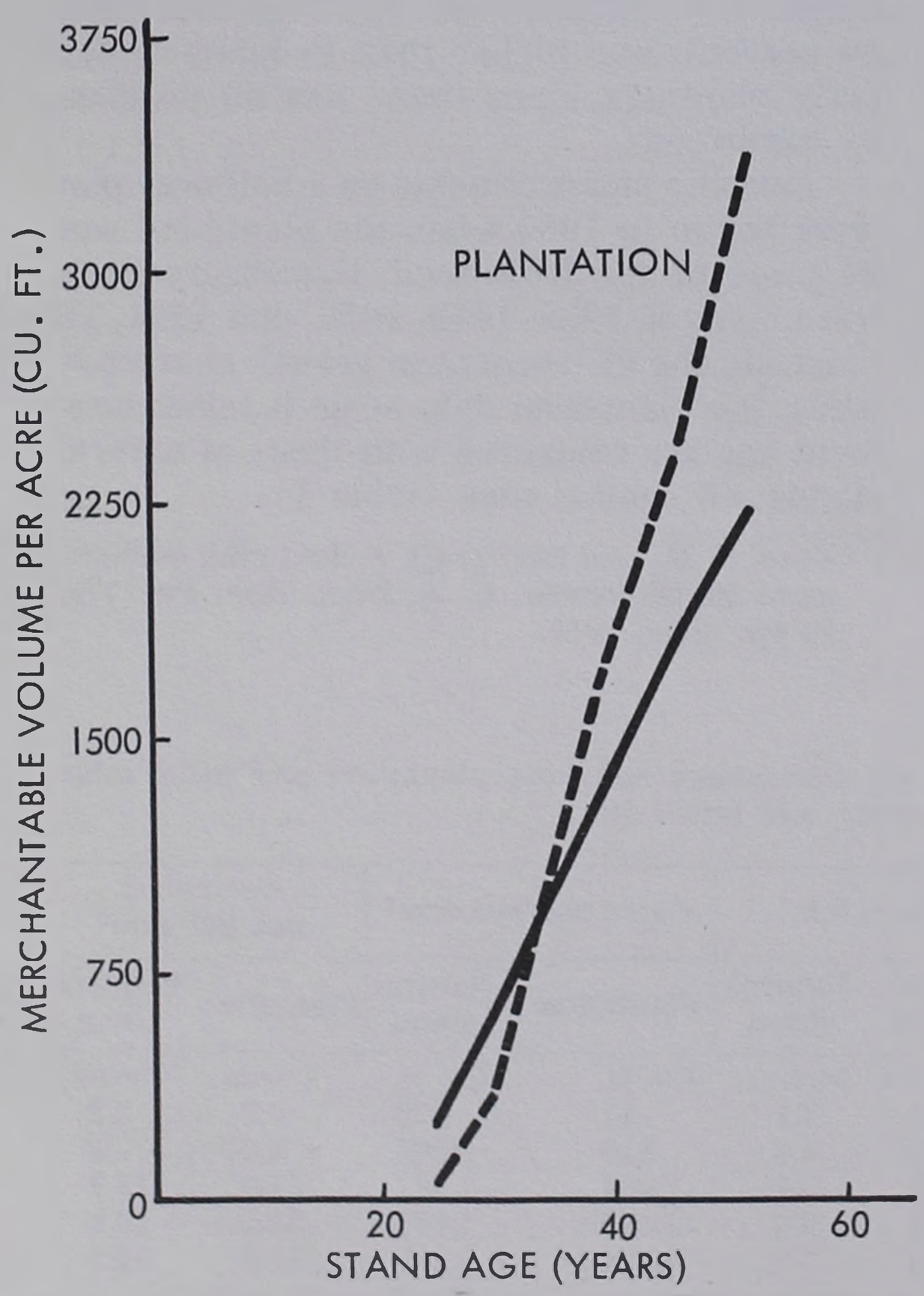

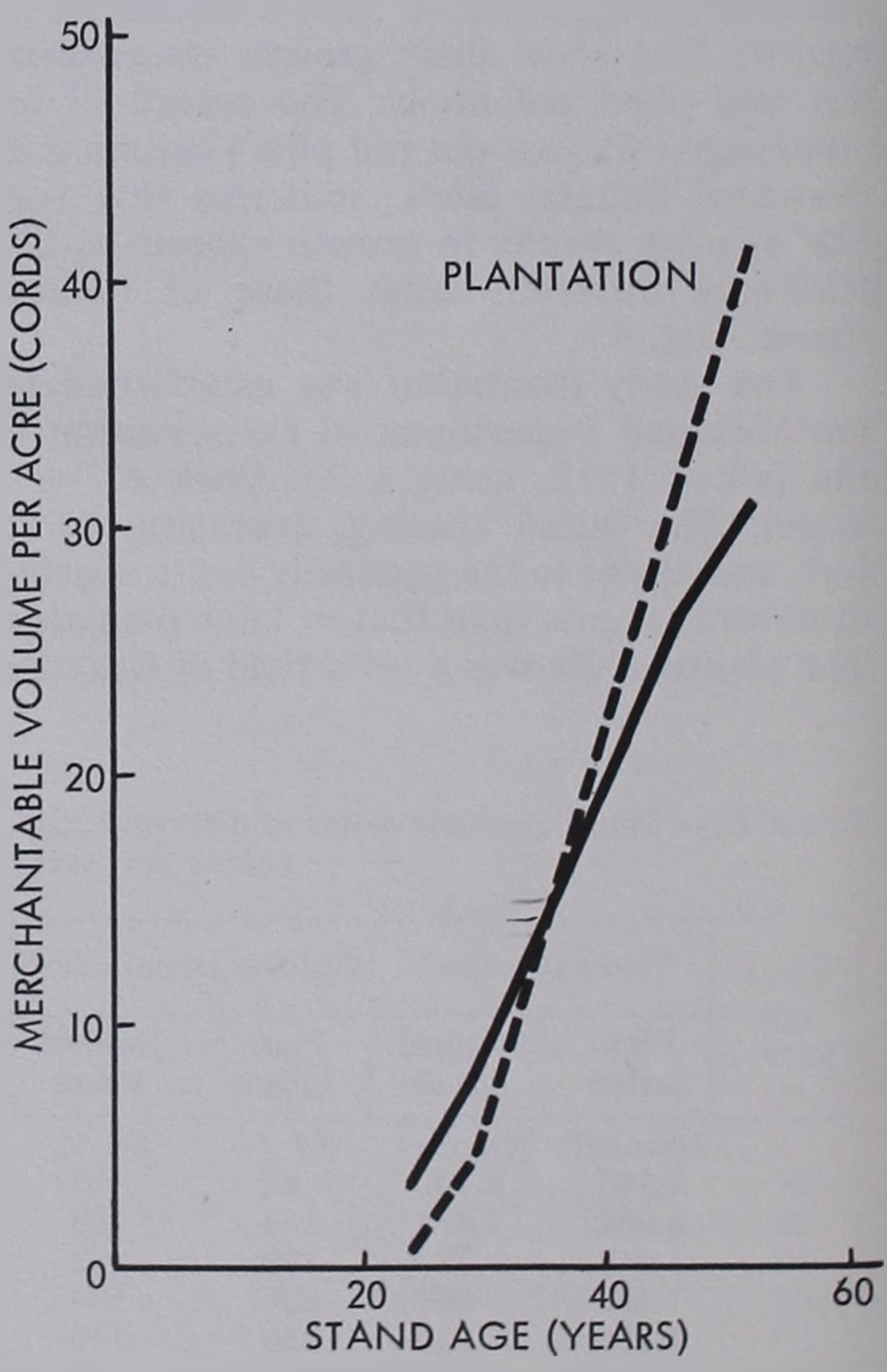

FIGURE 1. — Growth characteristics of an unmanaged red pine plantation and natural stands; site index 50.

The regular spacing in the plantation resulted in much lower mortality than occurs in most natural stands. Less than 10 percent of the planted trees died between ages 24 and 51 years, while 76 percent were lost in the natural stands. A significant differentiation of crown classes was first recorded at age 29 when the plantation had reached a density of 134 square feet per acre. At this density approximately 24 percent of the stems were in the intermediate crown class. The percentage of intermediate trees was still the same at age 51.

Basal area density of living trees in the plantation should culminate at about 250 square feet per acre. Of this stocking, however, only 215 square feet is expected to occur in trees increasing in stem diameter. The remainder is in overtopped trees that are not growing in diameter and will eventually be lost because of suppression.

Although the greater number of trees resulted in higher basal area densities in the plantation, the periodic diameter increment has progressively been reduced to only one-third that of natural stands. After age 29, when the density was 134 square feet, the rate of diameter increment rapidly dropped below that of the natural stands. Diameter growth of the 100 largest trees per acre showed a similar reduction at the same age and density, indicating that thinning should have been started.

The merchantable volume in plantations at any given age will vary because of differences in initial spacing and survival. Plantations established at wider spacings than observed here will tend to have higher volumes at earlier ages. At age 24 the volume yield in this closely spaced plantation was only 6 percent of the natural stand volume for comparable basal area density and average stand size. At 35 years of age the stand volumes were nearly equal. The merchantable cubic volume in the plantation at age 51, however, was 51 percent greater and the cordwood volume 33 percent greater than in the natural stands.

Most of the plantation volume is in small stems, with only 8 percent of the trees 8 inches or larger. Merchantable length of the stem averages only 47 percent of the total height, and the live crown length has been reduced to 39 percent. Quality of the wood is probably lower in the plantation not only because the trees are smaller but also because branch stubs are persisting. At a density of 236 square feet at 51 years of age little natural pruning has occurred.

The regular spacing in plantations is thus associated with higher survival, a rapid increase in basal area density to a maximum of about 250 square feet per acre, and a higher volume potential than normally occurs in the average natural stand. An estimated 3 million acres have been planted to trees in the Lake States. The successful plantations now comprise perhaps as much as one-fourth of the coniferous timber type, and the planted area is increasing by nearly 140,000 acres each year. With management to improve the size and quality of the final product, they should yield a large portion of the potential softwood timber requirements of the region.

R. M. GODMAN, Research Forester
(Forest Management)
Lake States Forest Experiment Station
N. F. SMITH, Staff Officer
Michigan Department of Conservation

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